Application of Biota Assessment Approach to a Site With a Past Uranium Mining and Milling Activities

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OUTLINE

- **INTRODUCTION** → Former uranium mine, biota assessment approach
- **MATERIALS AND METHODS** → field work, assessment with ERICA Tool
- **RESULTS** → Dose rates to biota, radiological risk to biota
- **CONCLUSION**
INTRODUCTION

- Uranium mining and milling activities in Slovenia were in full operation from 1985 to 1990 when 600,000 tons of uranium ore were processed during that time.

- The mine has two disposal sites with U-mill tailings deposited at the Boršt and red mud with spoil and lower grade ore at the Jazbec site.
Emission of natural radionuclides to the nearby habitats has often occurred due to flow of tailings and mine waters to the local streams (Todraščica and Brebovščica)
Mill tailings disposal site:
0.6 Mt (375,000 m$^3$, 4.11 ha) of hydro-metallurgical tailings (residue of U ore processing: SiO$_2$, CaCO$_3$, SO$_4^{2-}$ salts):
1.0 Bq/g $^{238}$U, 4 Bq/kg $^{230}$Th and 8.6 Bq/g $^{226}$Ra

Minor waste rock piles:
70 kt, 143 kt

Waste rock pile:
1.5 Mt of waste rock plus red mud (50 kt; precipitate of U leaching solution produced by neutralisation with lime): CaSO$_4$, Fe(OH)$_3$, 0.5 Bq/g $^{238}$U, 62 Bq/g $^{230}$Th and 0.2 Bq/g $^{226}$Ra

Panoramic view at the Žirovski vrh area, size 4 x 4 km - view towards south
Mine area was under constant monitoring surveillance from the beginning of mine operation, with aimed to measure critical radionuclides, such as U-238, Ra-226, and Pb-210 in water, sediment, soil, fish, and lichens.

Due to long-term radioactivity discharge to the local streams, the potential radiological risk to freshwater and terrestrial biota could be observed.

Biota risk assessment should be performed.
MATERIALS AND METHODS

- ERICA Tool, level Tier 2 was applied for the biota risk evaluation

- Native aquatic and terrestrial species, such as Brown trout, Stone crayfish, Soft rush, Marsh marigolds and Tall Moor Grass were assumed as target organism exposed to potential radiation impact

- Ra-226, U-238 and Pb-210 for aquatic biota and Ra-226, U-238 and Th-230 for plants were included in the assessment

- Monitoring data were used as input data for the assessment
A case of assessed biota in the vicinity of a former uranium mine

Brown trout

Stone crayfish

Tall Moor Grass

Marsh marigolds

Soft rush
Monitoring and ERICA default CR values were applied in the model.

The screening dose value of 400 µG h⁻¹ was used in the assessment as recommended by the IAEA and U.S. DOE for aquatic organisms and terrestrial plants.

Target organisms used in the model were created using real geometry and mass data.
RESULTS

➢ Aquatic biota → total dose rates per organism
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Terrestrial plants → total dose rates per organism

![Bar chart showing total dose rates per organism for different plants in 2009 across two sites: contaminated and control. The chart indicates significantly higher dose rates at the contaminated site for marigold, grass, and rush.](image-url)
- Biota risk evaluation - no environmental risk from ionising radiation to aquatic and terrestrial biota was observed as screening value 400 µGy h⁻¹ was not exceeded.

- Stone crayfish would be exposed to environmental risk in the case of ERICA screening dose value (10 µGy h⁻¹) but in our case this would be negligible due to application of higher dose limit for the assessed organisms.
CONCLUSIONS

- Assessment revealed that no environmental risk to aquatic biota and terrestrial plants was observed due to radioactivity discharge into the local streams.

- Predicted dose rates to aquatic biota were the highest during the mine operation in both streams.

- Todraščica stream resulted in higher biota dose rates compared to Brebovščica stream.

- Stone crayfish received evidently higher dose rate compared to Brown trout.
Soft rush received the highest dose rate among terrestrial plants.

Other organisms should be assessed due to their presence in the local streams.

Application of other models is suggested to compare the results.
Average yearly concentrations in air at the Todraž site
Sampling sites for Rn using track detectors (FK, Karlsruhe)
Contribution of the mine Rn
Average yearly Rn concentrations using charcoal adsorbers
Rn concentrations (track detectors) at two waste piles
Average yearly concentrations of U in Brebovščica and Todražčica streams

Brebovščica
Todražčica
Brebovščica - povprečje
Todražčica - povprečje
Average yearly concentrations of Ra in Brebovščica and Todražčica streams
Average yearly concentrations of Pb-210 in Brebovščica and Todražčica streams
Concentrations in one of the wells
Activity concentrations of U-238 in sediments
Activity concentrations of Ra-226 in sediments
Activity concentrations of Pb-210 in sediments
Effective dose due to inhalation of long-lived radionuclides
Effective dose due to inhalation of short-lived Rn progenies
Effective dose due to drinking river water
Povprečje

Efektivna doza (mSv)

Overall effective dose due to RŽV
THANK YOU FOR YOUR ATTENTION!